

II. "On an Electrodynamic Balance." By H. HELMHOLTZ, For.
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In order to avoid the disturbances produced by the variations of direction and intensity of terrestrial magnetism in measuring the intensity of galvanic currents by their electromagnetic effects, I have tried to construct an electrodynamic balance. I have suspended at the ends of the lever of a smaller chemical balance, instead of the scales, two coils of copper wire, their height being equal to the diameter of the cylinder around which the wire is coiled up. Their axis is vertical, and they are suspended in such a manner that they cannot turn around this axis. Two larger spirals of the same height, but of greater radius, are placed into a fixed position, borne by a horizontal metallic rod, the middle of which is fixed on the column bearing the balance. The connexions of the wires are arranged in such a way that one of the movable coils is attracted by the fixed coil, the other is repelled. Both the fixed coils are placed a little higher than the movable coils. The attracted coil rises, the other sinks down as soon as a current passes through the circuit.

There are two difficulties to be overcome in the construction of such a balance. At first, the current must be introduced into the movable spirals without diminishing their mobility, and without introducing places of contact of too small a pressure, which would make the resistance variable. I have succeeded to do this in a very satisfactory manner by using a kind of very thin sheet-brass, used for playthings of children, called in German "Rauschgold" (tinsel), because it looks like gold, and makes a crackling noise when it is moved. Strips of this, about 30 centims. long and 6 or 7 millims. broad, are very flexible, and show no signs of internal friction, their resistance to electric currents is very moderate, and they are not easily heated even by strong currents, because they have a relatively large surface in contact with air. I have connected each of the movable spirals with the other wires conducting the current by two such strips hanging loosely down from four pieces of brass fixed at the upper parts of the case of the balance. I may be allowed to remark, that strips of the same kind, and of greater length, are very useful to demonstrate the action of a magnet on a movable current. If you suspend the strip so that it hangs down in a curve, it is attracted, repelled, even raised against gravity, or coiled up around the magnet with great rapidity, in a very striking way.

The second difficulty is to bring the coils into such a position that neither the stability nor the sensibility of the balance is impaired. In order to do this, it is necessary that the intensity of the electrodynamic force does not vary sensibly during the usual small oscillations

of the balance. Now the force is zero if the middle of the movable coil is at the same height as that of the fixed coil. The force is again zero if the distance of the two coils becomes infinite. Between those two zero points there exists a maximum value of the force, which corresponds nearly to that situation where the upper surface of one of the coils is at the same height as the under surface of the other. Between the central position of the two coils and this position of maximum force, therefore, the differential coefficient of the force related to increasing distance of the centres is positive, and turns into negative when we pass the position of the maximum. This differential coefficient becomes again zero at an infinite distance. Therefore, between the position of maximum force and infinite distance there must be a distance where the differential coefficient of the force has itself a negative maximum, and the second differential coefficient, therefore, is zero. This is the position which must be given to the coils. As always the distance of one pair of the coils is diminished as much as that of the other pair is increased, the variation of the force depends only on the second differential coefficient. If this is positive, the electric current produces unstable equilibrium; if it is negative, the stability of the equilibrium is increased; that is to say, the balance becomes less sensitive than it is without current. If the coils are brought into the right distance, neither the sensibility nor the stability of the balance is altered, and by this circumstance itself the right position can be found out.

If the instrument is well adjusted, you can determine the weight which balances the electrodynamic force with errors not exceeding one milligramme. As the force exerted by the current is proportional to the square of its intensity, you determine the intensity of a current, which is counterbalanced by one gramme with an accuracy of $\frac{1}{2000}$, and the force which opposes the electrodynamic force and measures it is gravity alone, and therefore not subject to any variations, like those of terrestrial magnetism, or like the elasticity of a twisted wire on which one of the coils is suspended.

The observations of the electrochemical equivalent of the current corresponding to one gramme of weight, performed by different observers during the course of last year, have given a very satisfactory agreement.

III. "On the Internal Forces of Magnetized and Dielectrically Polarized Bodies." By Professor H. HELMHOLTZ, For. Mem. R.S. (Oral Statement at the request of the PRESIDENT.)

The Society then adjourned over the Easter Recess to Thursday, April 28th.